THE THEORY OF EVOLUTION IN GERMANY*

II.

WE must now examine how the primitive organisms have originated, or rather the single primordial organism from which all others have issued. Lamarck has attempted to solve the problem by his hypothesis of *archigony* or primitive being. Darwin avoids touching this question, doubtless to leave a last refuge for the hypothesis of a creation, and to make a final concession to the spiritualist systems. Haeckel shows no such caution; he is willing neither to renounce the scientific explanation of the phenomenon, nor to abandon the ground of natural philosophy to go astray upon that of faith or poetry; before resigning himself to the incomprehensible, he proceeds to explain, by a mechanical hypothesis, the primordial production of life.

He admits first, as to the origin of the earth, the system of Laplace, of whom Kant, about 1755, was the precursor, in his "Theory of the Heavens." This system is in harmony with all the phenomena at present known, and has not been found to disagree in any single instance. Moreover, it has the advantage of being purely mechanical, and of not requiring a resort to any supernatural force. This theory, consequently, plays the same part in cosmogony, and especially in geology, that the theory of Lamarck does in biology, and especially in anthropology. Both are founded exclusively upon efficient, and not upon final and intelligent causes. Both fulfil the conditions of a scientific theory, and have the same title to universal adoption, until the time when even better hypotheses shall be discovered. Haeckel, however, acknowledges that the theory of Kant and Laplace has a feeble foundation upon two points which it cannot explain—the heat to which is due the gaseous mass which formed the primitive world, and the rotatory movement impressed upon that mass. But every attempt to explain these facts leads us inevitably to the untenable theory of an absolute beginning.

We can no more conceive an absolute beginning for the eternal phenomena of movement than we can imagine an absolute end. The universe is, in the order of space and time, immense and without limits. It is eternal and it is infinite. The great law of the conservation of energy, which has become the basis of all our views of nature, does not allow of any other conception. The world, so far as it is accessible to our knowing faculties, appears to us as an uninterrupted chain of movements which determine a continual change of forms; each form is only the transitory result of a sum of phenomena of motion; but under this change of forms, force remains eternally indestructible.

Life could not commence before the earth had cooled sufficiently to allow the water, which had hitherto been in a state of vapour, to become liquefied and to be deposited on the surface; for all animals and all plants, all organisms in short, consist for the most part only of water combined in a particular manner with other materials. But how is it possible to conceive the commencement of organic life? In answer to this question, Haeckel examines first the relations which exist between organisms and the inorganic kingdom, from the standpoint successively of chemistry, of form, and of motion.

Chemistry teaches us that there does not enter into the material composition of living beings, absolutely any substance, which is not found in inanimate nature. There does not exist any distinct organic matter. The differences which exist between organic beings and the inorganic world cannot then have their essential foundation in the different nature of the substances of which they are composed, but only in the processes by which these substances enter into combination. A greater or less density suffices to place a chasm between two groups of bodies; moreover, the degree of density does not depend upon the component elements, but solely upon the temperature: by heating sufficiently a solid body, we can make it pass first into the liquid, and then into the gaseous state. In contrast to these three degrees of density of inorganic bodies, the solid, the liquid, and the gaseous, Haeckel attributes to living beings a fourth state of aggregation which is proper to them, is neither solid like stone, nor liquid like water, but appears to be a mean between the two, and consists always in a characteristic combination of water with organic matter. This mixed state, which is of the highest importance in the mechanical explanation of the phenomena of life, is explained in its turn, according to Haeckel, by the physical and chemical properties of a simple substance, viz. carbon. This element has a peculiar tendency to form with other elements, in the most diverse proportions of number and weight, complicated and very various combinations. Above all it enters into combination with three other elements, oxygen, hydrogen, and nitrogen, in order to form the indispensable base of all vital phenomena, viz. albumen or protein. Certain very simple organisms, such as the monads, are only small masses of semi-liquid, semi-solid albumen; and it is the same for the most part with other organisms in the earliest stages of their development, when they are as yet only simple cells; albumen then takes the name of *plasma* or protoplasm, and this plasma is now considered as the starting-point of all vital phenomena. Thus it is not more difficult for us to give a general explanation of life than it is to explain the physical properties of inorganic bodies. It is true that ultimate causes are hidden from us; but it is the same in the inorganic world. If we are unable to say why such a combination engenders a cell, no more can we understand why gold crystallises into a tetrahedric or antimony into a hexagonal form. Thus, from a chemical point of view, it impossible to establish any difference between the organic and inorganic kingdoms.

Again, with respect to Form, the simple and homogeneous structure of crystals is opposed to the heterogeneous and complicated structure of living beings; but certain inferior organisms, such as the monads, are formed solely of a small albuminous mass of a structure as simple as that of a piece of silex. Animals and plants thus appear, at first sight, not to have any mathematically determined form like crystals; but Haeckel has pointed out among the *Radiolaria* and many other protozoa a great number of inferior organisms, which, like crystals, may be referred to regular geometrical forms. He has also, in his "General Morphology" (pp. 375—574), presented an ideal system of stereometric forms which explain both the actual forms of inorganic crystals, and those of organic individuals. There is finally a large number of living beings completely amorphous, such as the monads, the *amœbæ*, &c., whose shape is constantly changing, and in which it is as impossible to recognise a determinate form as it is in the case of amorphous inorganic beings, such as non-crystallised stones, precipitates, &c. In respect of form, then, there is no more essential difference between organic and inorganic beings.

Let us now consider Movement. At the present day, as the hypothesis of a vital force is completely abandoned, it is necessary, according to Haeckel, to refer all manifestations of life, and particularly the phenomena of nutrition and reproduction, to the properties of carbon, or at least of hydrogen. With regard to growth, the only difference between living beings and inorganic bodies lies in this, that the former grow in size by intersusception, that is, by the introduction of new particles into their interior, while the latter are enlarged by opposition, by the external addition of new matter. The external conformation is determined, in crystals as well as in organisms, by the laws of adaptation; the form and the size of the crystal depends on the circumstances in which it is placed, on the vessel in which the process of crystallisation goes on, on temperature, on atmospheric pressure, on the presence or absence of foreign bodies. The form of every crystal, as well as the form of every organism, is thus the result of the struggle between two factors,—an internal plastic force proceeding from the chemical constitution of the body, and an external plastic force the result of the influence of the medium. Consequently, if growth and form are processes of life, there is no reason for refusing to attribute life to the inorganic world, as well as to organisms.

As soon as this unity of organic and inorganic nature is fairly established, the problem of primordial or spontaneous generation presents much fewer difficulties. If the attempts which up to the present time have been made to bring about experimentally spontaneous generation have not led to positive results, the only inference to be drawn is, that we are as yet ignorant of the conditions in which it takes place, conditions which, moreover, we may perhaps not now be able to reproduce. It is evident that all the matter which has become organic, would, at the time when the earth was not sufficiently cooled, be mixed in the atmosphere in a form of which we are ignorant. How are we able to reproduce completely in our laboratories all the chemical, electric, and other conditions of that primitive atmosphere? Meanwhile, the combinations of carbon which have already been obtained artificially, give ground for hoping that ere long we shall be able to reproduce the most important of all, the matter of the *plasma* or albumen.

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* Continued from p. 352.

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But the most powerful arguments in favour of spontaneous generation are furnished by the study of the monads, the simplest of all organisms, which Haeckel has made the subject of a special monograph. Seven species of these are known, some of which live in fresh water, and some in the sea, all of them consisting of small formless masses of albuminous combinations of carbon, and differing from each other only in their mode of reproduction, development, and nutrition. As these living beings do not present any complication of diverse parts, any division of functions or of organs, as all the phenomena of life with them proceed in a homogeneous manner, and without determinate form, it is very easy to conceive of their spontaneous generation. There is indeed one species which even at the present day appears to be born spontaneously, it is that which has been discovered by Huxley, and which has been described under the name of *Bathybius Haeckelii*. It inhabits the sea at depths of from 12,000 to 24,000 feet; it covers the ground sometimes as a network of strings of *plasma*, and sometimes in little heaps. The nucleus of it seems to be formed by a local condensation of albuminous matter, and the monad becomes a cell. As we have seen above that all animals and plants have their starting-point in a cell, it is allowable to suppose that all species are only monads gradually modified by natural selection.

It will be seen that all the views of Haeckel are founded upon the cellular theory as it has been formulated by Schleiden and Schwann. Haeckel always distinguishes two elements—*cytodes* and cells properly so called, reuniting these two elements under the generic name of *plastides*. Cytodes are parcels of plasma destitute of a nucleus, while cells are plastides endowed with a nucleus; each of these two species being subdivided in its turn into two groups, according as they are or are not enveloped by an exterior membrane. Hence there are four forms of *plastides*: (1) Naked or primitive cytodes, like the present existing monads, the only ones which can proceed directly from spontaneous generation; (2) Cytodes with membranes (*lepocytoda*), proceeding from naked cytodes by a coagulation of the exterior portion of the plasma; (3) Naked or primitive cellules by coagulation of an interior portion of the plasma; and (4), Membranous cells, proceeding either from membranous cytodes by interior condensation of the nucleus, or from naked cells by the external formation of a membrane.

There are two theories, one of which may be adopted. Either the monads at present known are descended by propagation from primitive monads and have preserved the same form for millions of years; or, even at this present time, as was the case in the earlier days of organisation, they owe their existence to repeated acts of spontaneous generation. The latter hypothesis is in no respect less probable than the former.

(*To be continued.*)

SCIENTIFIC SERIALS

Journal de Physique Théorique et Appliquée. Par J.-Ch. d'Almeida, Prof. de Physique au Lycée Corneille, Paris. We have before us the numbers of the "Journal de Physique théorique et appliquée" extending over the first year of its existence. The object of the journal, which consists of monthly parts of about forty pages each, is stated in the preface to the first number (January 1872) to be the giving of a new impulse to the study of physical science. This its authors aim at doing "by unfolding the more recent and less known theories, by describing the experiments upon which they rest, by indicating the most easy means of repeating them, and by narrating the progress which physical science makes day by day in France and other countries." By the execution of this project "they hope to interest everyone who is acquainted with the principles of science, to enliven teaching, to excite the spirit of research, and to stimulate discoveries." The journal, which is principally mathematical in its treatment of the subjects, differs considerably from such a journal as the "Philosophical Magazine." The original articles in it are few and unimportant. There are criticisms on and reprints of articles selected from other journals, and bearing on the subjects to which this is devoted; but the distinguishing feature of the journal consists in articles, continued generally through several successive numbers, reproducing and elucidating important theories and investigations, which are thus presented in an easily accessible form. Thus the first number starts off with an article on "Electrostatic measures." We also have a series of articles by M. Terquem on electricity and magnetism, beginning in No. 1 with a short article stating the experiments by which it is demonstrated that free electricity resides only in the surfaces of conductors, and then proceeding in No. 2, and subsequent numbers, to treat of the various units employed in measuring quantities of electricity and magnetism, and the relations which exist between them. The reader will gather the character of such articles as those to which we refer, from the following enumeration of the titles of a few others of those which are more important:—"On the action of a magnet on a magnetised molecule at a distance," "On the analogy between the propagation of heat and the distribution of electricity," "On the propagation of permanent electric currents," "On the employment of the wave theory in optical calculations," "On Electrodynamics and the theory of induction" These articles do not contain original matter, nor for the most part do they contain matter arranged in an original way, but they contain useful and concise expositions of the subjects, reproducing such points as the proof of Ampère's theory, Ohm's laws, the method of comparing electro-magnetic and electro-static units, and the like. Such articles will be principally useful to those who cannot obtain the original investigations, or who desire to avoid the labour of consulting those manuals in which these investigations may be included. The journal seems certainly well calculated to extend a knowledge of and interest in the subjects with which it deals, and thus to assist in achieving the end which it proposes to itself.

JAMES STUART

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 20.—"On the Temperature at which *Bacteria*, *Vibriones*, and their Supposed Germs are killed when immersed in Fluids or exposed to Heat in a Moist State." By H. Charlton Bastian, M.D., F.R.S., Professor of Pathological Anatomy in University College, London. (*Continued from p.* 413.)

The facts just cited concerning the behaviour of thin films of turbid infusions which had been heated to different temperatures gave me the clue as to the proper direction of future work. It would seem that when mounted in the manner described, such thin films of infusion continue capable of supporting and favouring the multiplication of any already existing *Bacteria* and *Vibriones*, although, under such conditions, no new birth of living particles appears to take place even in these fluids. The question then arose as to whether, by subjecting larger quantities of the same infusions to any particular sets of conditions, we could ensure that they also should continue to manifest the same properties. Because if so, it would be almost as easy to determine the death-point of *Bacteria* and *Vibriones* when exposed to heat in these infusions, as it had been to determine it for the saline solutions already mentioned.

It was pointed out by Gruithuisen early in the present century that many infusions, otherwise very productive, ceased to be so when they were poured into a glass vessel whilst boiling, and when this was filled, so that the tightly-fitting stopper touched the fluid. Having myself proved the truth of this assertion for hay-infusion, it seemed likely that, by having recourse to a method of this kind, I should be able to lower the virtues of boiled hay and turnip infusions to the level of those possessed by the boiled saline solution with which I had previously experimented—that is, to reduce them to a state in which, whilst they appear quite unable of themselves to engender *Bacteria* or *Vibriones*, they continue well capable of favouring the rapid multiplication of such organisms.

This was found to be the case, and I have accordingly performed upwards of one hundred experiments with inoculated portions of these two infusions raised to different temperatures. The mode in which the experiments were conducted was as follows:—

Infusions of hay and turnip of slightly different strengths were employed. These infusions having been first loosely strained through muslin, were boiled for about ten or fifteen minutes, and then whilst boiling strained through ordinary Swedish filtering-paper into a glass beaker which had previously been well rinsed with boiling water. A number of glass bottles or tubes were also prepared, which, together with their stoppers or corks, had been boiled in ordinary tap water for a few minutes.* They were taken out full of the boiling fluid; and

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* The vessels employed have varied in capacity from two drachms to four ounces; some have been provided with glass stoppers and others with very

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